

A COMPARATIVE STUDY IN AXIAL LENGTH OF EYE AND RADIUS OF CURVATURE OF CORNEA BETWEEN MYOPES AND EMMETROPES IN INDIAN POPULATIONTasneem A. F¹, Vittal Nayak I², Shwetha B. A³**HOW TO CITE THIS ARTICLE:**

Tasneem A. F, Vittal Nayak I, Shwetha B. A. "A Comparative Study in Axial Length of Eye and Radius of Curvature of Cornea between Myopes and Emmetropes in Indian Population". Journal of Evolution of Medical and Dental Sciences 2015; Vol. 4, Issue 70, August 31; Page: 12097-12111, DOI: 10.14260/jemds/2015/1744

ABSTRACT: BACKGROUND AND OBJECTIVES: This study would help us understand the pathophysiology of Myopia in Indian population in a better way. The hypothesis being tested is that "the axial length of eye and radius of curvature of cornea is associated with myopia". The main objectives of the study are; 1. To compare the axial lengths in myopes and emmetropes. 2. To compare the radii of curvatures of cornea in myopes and emmetropes. 3. To study the changes in axial length and radius of corneal curvature in near-work induced transient myopia. 4. To study the association of parental myopia and near work on the onset of myopia. **METHODS:** Emmetropic and myopic individuals who attend the Ophthalmology OPD at Vydehi Institute of Medical Sciences and Research Centre, Bangalore will be asked for participating in the study. Informed written consent shall be taken from all the subjects. A pre-structured proforma will be used to collect the baseline data. Detailed ocular clinical examination will be done for those who satisfy the inclusion and exclusion criteria. The sample size was 380 including the control and case groups. **RESULTS:** The data collected was entered in master charts and it was analyzed using statistical methods like mean, standard deviation, T-test and ANOVA. If the p-value associated with the standard deviation, T-test and ANOVA is small (<0.05), there is evidence to reject the null hypothesis in favour of the alternative. **INTERPRETATION & CONCLUSION:** A greater axial length of the eye was observed in the case group examined, irrespective of other factors such as changes in radius of curvature of cornea. Hence, axial lengthening is the main morphological factor related to myopia. The radius of curvature is not a determining factor of the refractive error, although we observed a tendency towards smaller radii of curvature in case group myopias. The cornea seems to play an emmetropizing role in preserving emmetropia or low myopia. This emmetropizing capacity could be insufficient when there is excessive axial lengthening of the ocular globe, with the consequent appearance of myopia.

KEYWORDS: Eye, Myopia, Emmetropia, Cornea, Ophthalmology, Bio-statistics, Axial-length.

INTRODUCTION: The refractive state of human eye is dependent on the balance of change in overall eye size and refractive components, namely, the cornea and crystalline lens.¹

The axial length (AL) is the distance from the corneal surface to an interference peak corresponding to the retinal pigment epithelium/ Bruch's membrane.^{2,3} The majority of axial length elongation takes place in the first three to six months of life and a gradual reducing rate of growth over the next two years,⁴ and by three years the adult eye size is attained.⁵ The cornea is the most powerful refracting surface of the optical system of the eye, accounting for two-thirds of the eye's focusing power. Production of a sharp image at the retinal receptors requires corneal transparency and appropriate refractive power. The refractive power of the cornea depends on its curvature and the difference in refractive indexes between it and air.⁶

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The interaction between axial length and corneal radius of curvature (CRC) has played a major role in the compensatory adjustments of the optical components of the eye towards attaining emmetropic state⁵. During the early years in life, the eye grows in such a manner that the refractive state tends towards emmetropia.^{7,8}

AL/CR ratio can provide information concerning the extent to which the lens has emmetropized by reducing its power concurrent with axial elongation.⁵ Myopia is a refractive defect of the eye in which collimated light produces image focus in front of the retina when accommodation is relaxed. This causes the image that one sees when looking at a distant object to be out of focus but in focus when looking at a close object.

Over the past several decades, myopia has become more prevalent in many countries. Studies of populations in China, India, Singapore, Australia and United States have all provided evidence of the rise in the prevalence of myopia. Although the increases in myopia prevalence has been shown to be greater in urban than rural populations due to the earlier start of formal education, it seems that nearly all communities are being affected. The aim of this study is to compare the axial length and corneal radius of curvature in myopes and emmetropes in Indian population.

NEED FOR THE STUDY: Myopia or short sightedness is a common cause of reversible blindness in India with a prevalence of 27%. Increase in axial length and decrease in radius of curvature of cornea are considered as two most significant factors associated with myopia, although there are conflicting opinions about the role of cornea in the appearance of myopia. Despite its high prevalence, the etiology of myopia is not fully understood, although there is clear evidence that environmental factors like near work and sleeping in a lighted room before the age of two plays a major role.⁹ In the aetiopathogenesis of myopia, strong association with family history of myopia has opined.¹⁰ Few studies have suggested relationship between near work, transient myopia and permanent myopicff.^{11,12} Most of these studies have been done in western population and there are limited such studies on the role of cornea in myopia and the association of parental myopia and of near work on myopia in Indian population.

Therefore this study would help us understand the pathophysiology of myopia in Indian population in a better way by comparing the extent to which either axial length or radius of curvature of cornea contributes to the degree of myopia. The hypothesis being tested is that “the axial length of eye and radius of curvature of cornea is associated with myopia”.

OBJECTIVES:

1. To compare the axial lengths in myopes and emmetropes.
2. To compare the radii of curvatures of cornea in myopes and emmetropes.
3. To study the changes in axial length and radius of corneal curvature in near-work induced transient myopia.
4. To study the association of parental myopia and near work on the onset of myopia.

MATERIALS AND METHODS:

Study Area: Vydehi Institute of Medical Sciences and Research Centre, Bangalore.

Study Design: Comparative clinical study.

Study Sample: It will comprise of healthy individuals visiting for routine eye check-up and clinically diagnosed myopia patients visiting outpatient department of Ophthalmology at Vydehi Institute of Medical Sciences and Research Centre, Bangalore.

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Study Period: December 2009 to April 2011.

Group A (Controls) - Emmetropic men and women with and without any family history of myopia and history of near work.

Group B (Cases) - Myopic patients attending the Ophthalmology department and who satisfy inclusion and exclusion criteria and those with and without any family history of myopia and history of near work.

The sample size was 380 including the case and control groups.

Inclusion Criteria:

- Study group: Group A: men and women subjects with 6/6 vision.
- Group B: Myopia patients who came with a history of short sightedness.

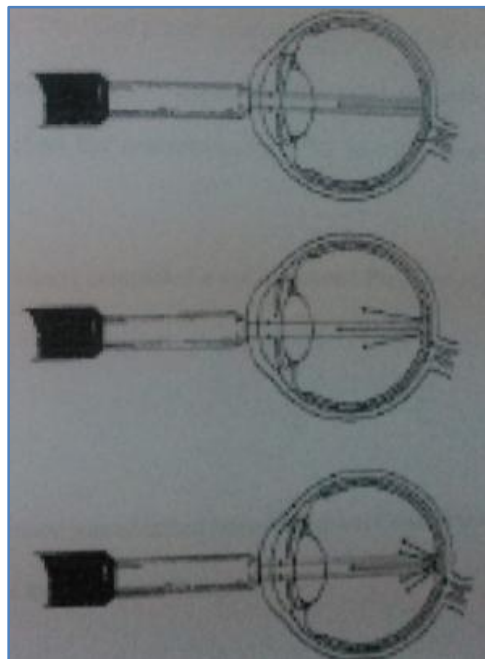
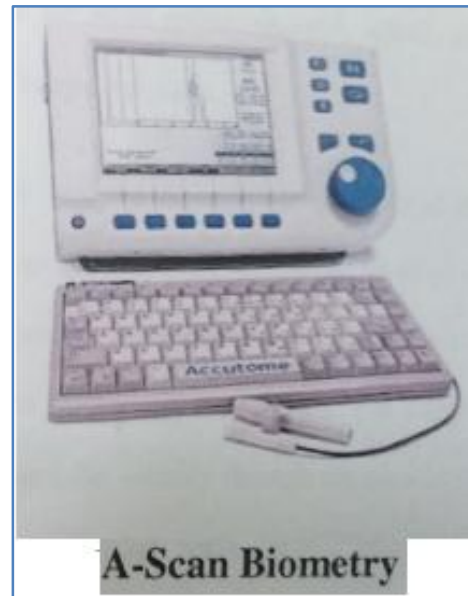
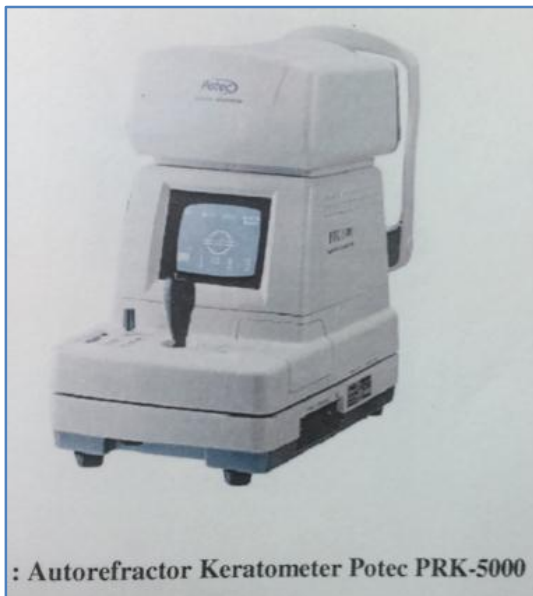
Exclusion Criteria:

- History of ocular trauma.
- History of ocular surgery.
- Subjects who are blind.
- Subjects with any other medical/surgical illness like diabetes mellitus, malaria or nuclear sclerotic cataract.
- Subjects who have keratoconus.
- Subjects who are on myotics like carbachol, demecarium, echothiophate, isofluorophate, neostigmine and physostigmine.
- Subjects suffering from dysentery or toxemia of pregnancy (Lens hydration changes).
- Contact lens users (Unless they discontinue contact lens usage 5 days prior to examination).
- Subjects who are on drugs to avoid drug reactions which may cause ciliary body edema like carbonic anhydrase inhibitors.
- Other ocular causes like glaucoma, night blindness, microcornea, pingecula, microphthalmos.

Study Methods: Emmetropic and myopic individuals who attend the Ophthalmology OPD at Vydehi Medical Sciences and Research Centre will be asked for participating in the study. Informed written consent shall be taken from all the subjects. A pre-structured proforma will be used to collect the baseline data. Detailed ocular clinical examination will be done for those who satisfy the inclusion and exclusion criteria.

- Autorefracto keratometer will be used for refraction testing and for measuring the radius of curvature of cornea. In this study Autorefractor Keratometer Potec PRK-5000 is used.
- A-scan Biometry will be used to determine the axial length of the eye.

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Method of Analysis: The filled pre-structured proforma and the details of the clinical examination were numbered; the responses were coded and entered on a Microsoft excel 2007 spread sheet and analysed using SPSS 10.0 for Windows and Microsoft Excel 2007.

Procedures: The subjects completed a pre-structured proforma regarding the history of myopia.

Ethical Clearance: Ethical clearance was obtained from the Ethical Committee at Vydehi Institute of Medical Sciences and Research Centre.

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RESULTS: Statistical Treatment of the Data: The data collected was entered in master charts and it was analysed using statistical methods like mean, standard deviation, T-test and ANOVA.

Level of Significance Reckoned as:

- + Suggestive significance (P value: $0.05 < P < 0.10$).
- Moderately significant (P value: $0.01 < P \leq 0.05$).
- ** Strongly significant (P value: $P \leq 0.01$).

The data was subjected to appropriate statistical treatment. The following are the statistical methods applied in this study.

Statistical Methods: Descriptive and Inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean±SD (Min-max) and results on categorical measurements are present in number (%). Significance is assessed at 5% level of significance. The following assumptions on data are made.

Sample Size Estimation:

- Formula used in Sample Size= Z^2pq/d^2 .
- Where, Z= standard normal deviate (1.98).
- p= Prevalence (0.19).
- q= 1-p= 0.81.
- d= error margin (0.05).
- The sample size was calculated to be 278 cases and 102 controls.

Sampling Methods: Inferential Statistical Analysis was done and Chi- Square Test, Fisher Exact Test and Student 't' test (Two tailed, independent) were used as sampling methods.

Statistical Software: The Statistical software namely SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, Systat 12.0 and R environment ver.2.11.1 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc.

Gender	Cases		Controls	
	No.	%	No.	%
Male	127	45.7	51	50.0
Female	150	53.9	51	50.0
Total	278	100.0	102	100.0

Table 1: Gender distribution in the study sample

Table 1 shows the gender distribution of the study sample. Out of 278 subjects in the case group, 127 were males whereas 150 were females. The control group consisted of equal number of male and females out of 102 subjects.

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Age in ears	Cases		Controls	
	No	%	No	%
18-20	45	13.3	11	10.8
21-30	121	43.5	52	51.0
31-40	112	39.9	39	38.2
Total	278	100.0	102	100.0

Table 2: Age distribution in the study sample for cases and controls

Table 2 shows the gender distribution of the study sample. Maximum percentage was recorded in the age group between 21-30 and 31-40 years in the case and control groups.

Refractive Errors	Cases	Controls	P value
Right			
Spherical	-3.53±1.93	0.11±0.16	<0.001**
Cylindrical	-1.03±0.88	0.00±0.00	<0.001**
Left			
Spherical	-2.81±1.84	0.12±0.19	<0.001**
Cylindrical	-0.90±0.66	0.00±0.00	<0.001**

Table 3: Comparison of Refractive error in study sample for cases and controls

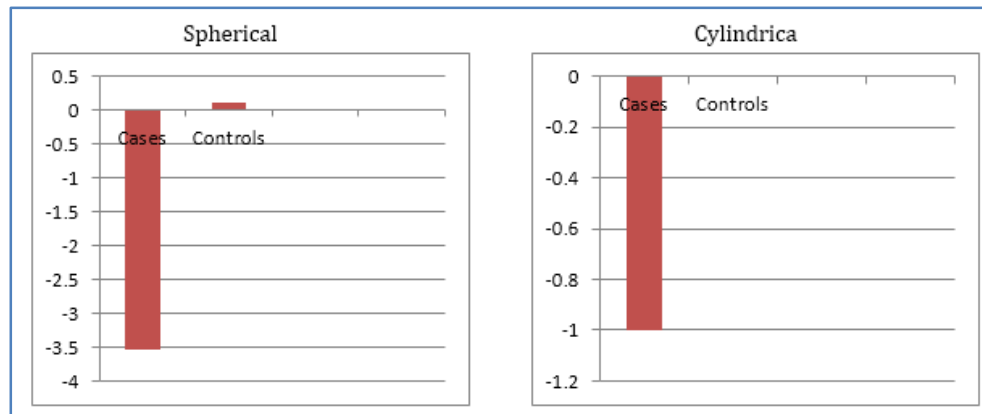


Table 3 shows the comparison of refractive error in study sample. There was a significant correlation in right and left refractive errors in case and control group ($P < 0.001$).

Keratometry	Cases	Controls	P value
Right	7.71±0.02	7.76±0.005	<0.001**
Left	7.71±0.03	7.76±0.004	<0.001**

Table 4: Comparison of Keratometry in study sample

Table 4 shows the comparison of Keratometry values in study sample. There was a significant correlation in right and left Keratometry values in case and control groups ($P < 0.001$).

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Axial length (mm)	Cases	Controls	P value
Right	24.25±0.96	23.52±0.84	<0.001**
Left	23.81±1.01	23.52±0.72	0.008**

Table 5: Comparison of axial length in study sample

Table 5 shows the comparison of axial lengths in study sample. There was a significant correlation in right and left axial lengths in case and control group ($P < 0.001$).

Variables	Cases (n=278)	Control (n=102)	P value
	Mean +/- SD	Mean +/- SD	
Refractive- spherical	-3.5±1.9	0.1±0.2	0.000**
Refractive- cylindrical	-1.0±0.8	0.0±0.0	0.000**
Keratometry	7.7±0.0	7.8±0.0	0.000**
Axial length (mm)	24.2±0.9	23.5±0.8	0.000**

Table 6: Outcome measures of variables in the study sample

**p value<0.0001

Table 6 shows the outcome measures of the studies variables in the sample population. The findings revealed that there is a significant correlation between the variables in both cases and control groups.

Variables	Male		Female		P value
	Cases (n=128)	Controls (n=51)	Cases (n=150)	Control (n=51)	
	Mean +/- SD	Mean +/- SD	Mean +/- SD	Mean +/- SD	
Refractive- spherical	-3.5±2.0	0.09±0.14	-3.54±1.83	0.12±0.18	0.000**
Refractive- cylindrical	-1.05±0.90	0.00±0.00	-1.01±0.86	0.00±0.00	0.000**
Keratometry	7.71±0.03	7.76±0.00	7.71±0.02	7.76±0.00	0.000**
Axial length (mm)	24.36±0.96	23.47±0.79	24.12±0.94	23.57±0.89	0.000**

Table 7: Outcome measures of variables among genders in the study sample

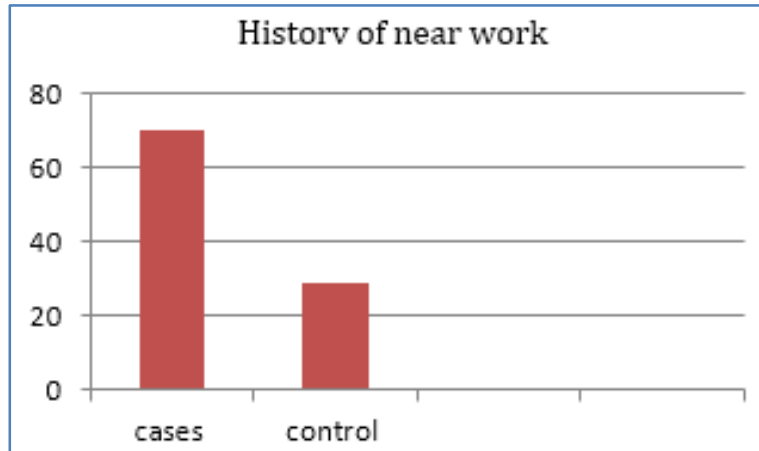
**p value<0.0001

Table 7 shows the outcome measures of the studies variables among genders in the sample population. It was noted that there was a significant correlation between the studied variables in both the genders.

History of near work	Cases	Controls	P value
Yes	199(70.5%)	302(29.2%)	0.424
No	79(29.5%)	72(58.8%)	
Total	278(100.0%)	102(100.0%)	

Table 8: Comparison of incidence of history of near work in study sample

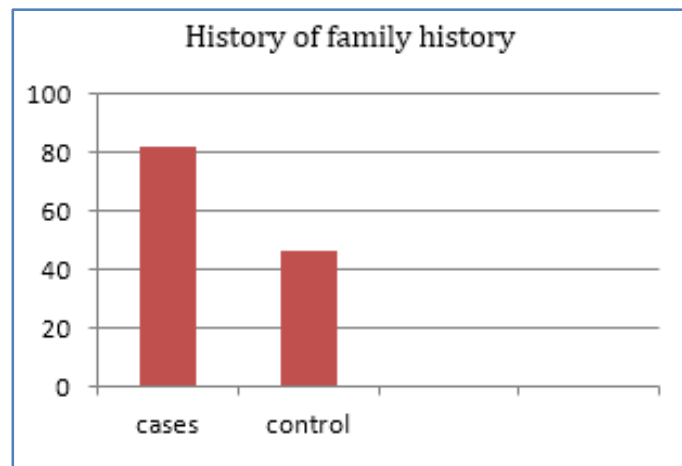
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The most relevant clinical environmental factor typically associated with myopia in humans is near work. Table 8 compares the incidence of history of near work in the sample population. It was found that the 70.5% of the cases recorded yes for the history of near work which is slightly higher in case of control groups (29.2%).

Family History	Cases	Controls	P value
Yes	227(82.3%)	47(46.7%)	<0.001**
No	61(17.7%)	55(53.3%)	
Total	278(100.0%)	102(100.0%)	

Table 9: Comparison of family history in the study sample



With reference to the family history in the sample population, it was noted that 82.3% of the case group had family history where as it was 46.7% in the control group (Table 9).

CORRELATION ANALYSIS: Figure 4 shows the Scatter plot for the refractive error (spherical and cylindrical) and axial length values observed in the study sample. Correlation was found high in the case of refractive error and axial lengths in the whole population ($r^2= 0.394$).

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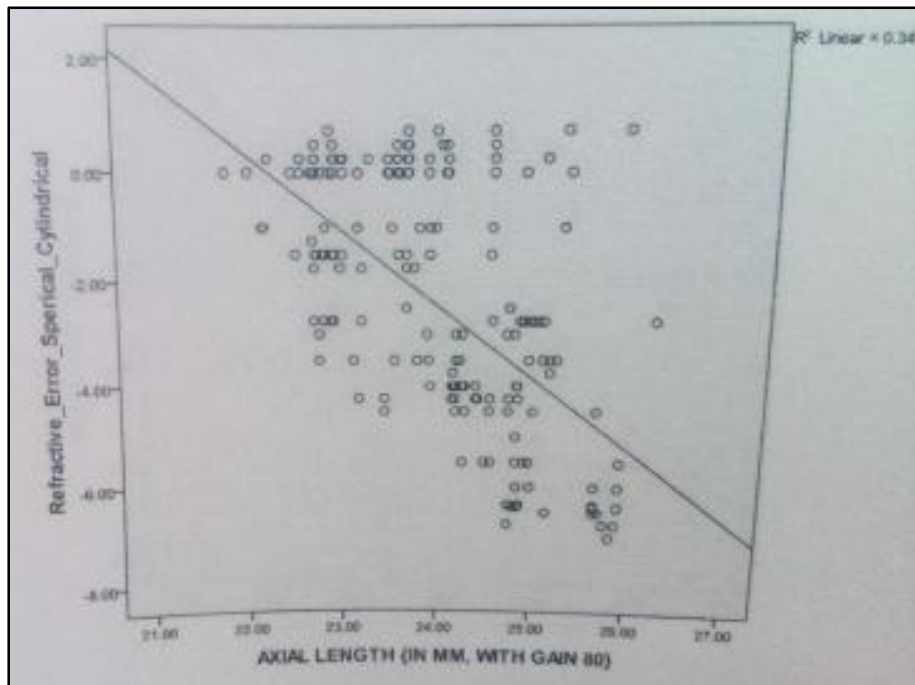


Fig. 4: Scatter plot for the refractive error Vs axial length values in whole population

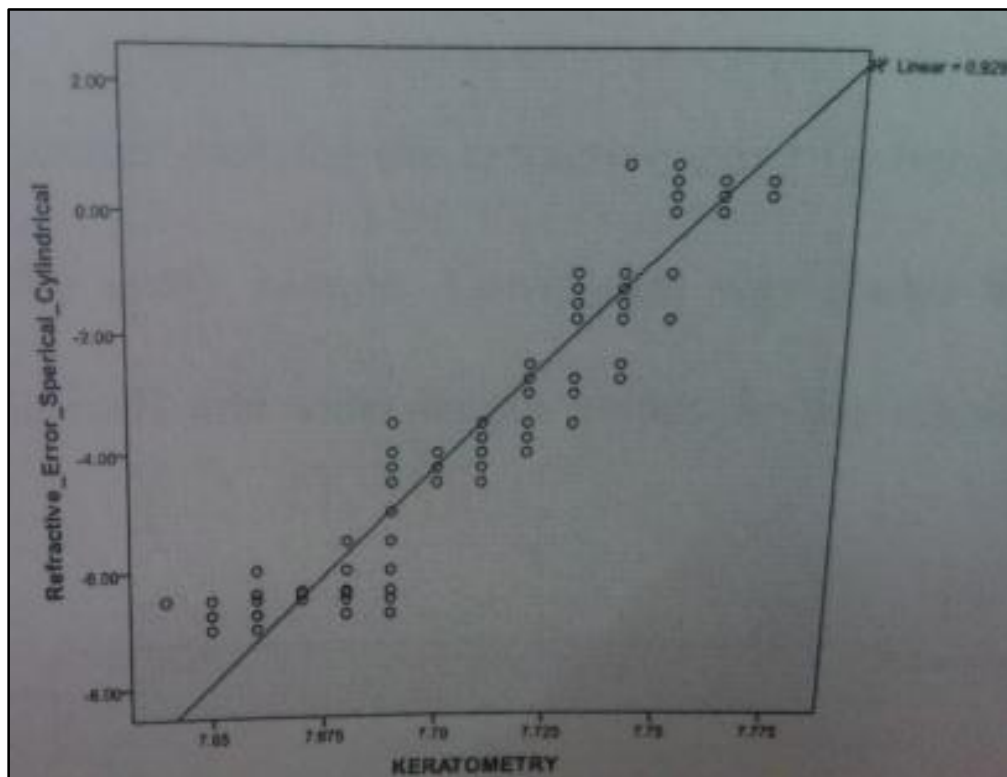


Fig. 5: Scatter plot for refractive error Vs Keratometric values in whole population

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Figure 5 shows the scatter plot for the refractive error (spherical and cylindrical) and Keratometric values observed in the study sample. Correlation was found high in the case of refractive error and Keratometric values in the whole population ($r^2 = 0.929$).

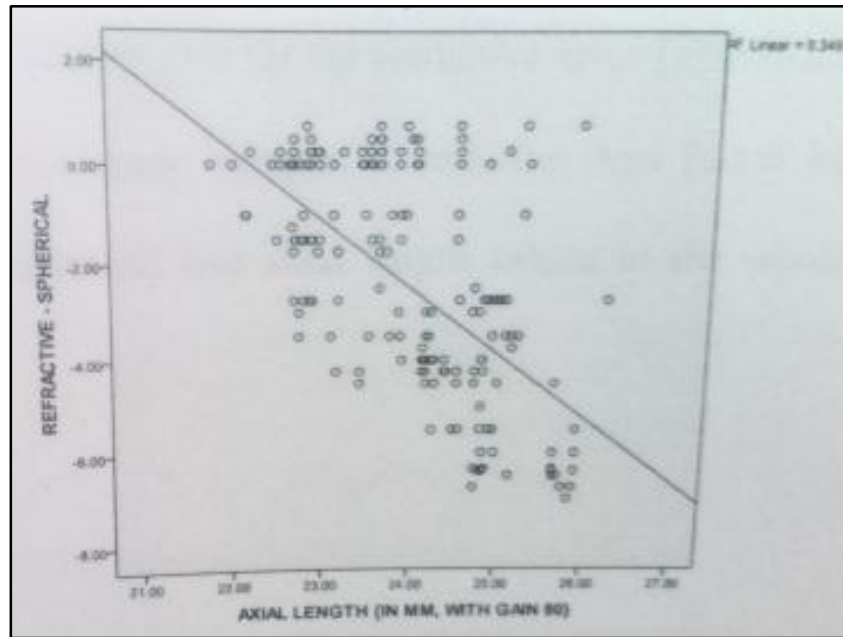


Fig. 6: Scatter plot for refractive error (Spherical) Vs Axial length in whole population

Figure 6 shows the scatter plot for the refractive error (spherical) and axial length values observed in the study sample. Correlation was found high in the case of refractive error (spherical) and axial length values in the whole population ($r^2 = 0.349$).

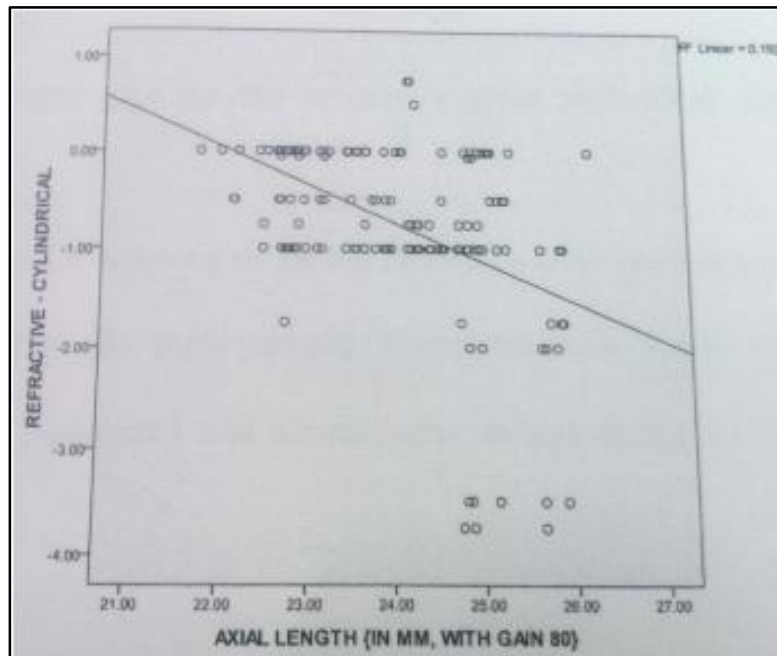


Fig. 7: Scatter plot for the refractive error (Cylindrical) and axial length values

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Figure 7 shows the scatter plot for the refractive error (cylindrical) and axial length values observed in the study sample. Correlation was found high in the case of refractive error (cylindrical) and axial length values in the whole population ($r^2 = 0.192$).

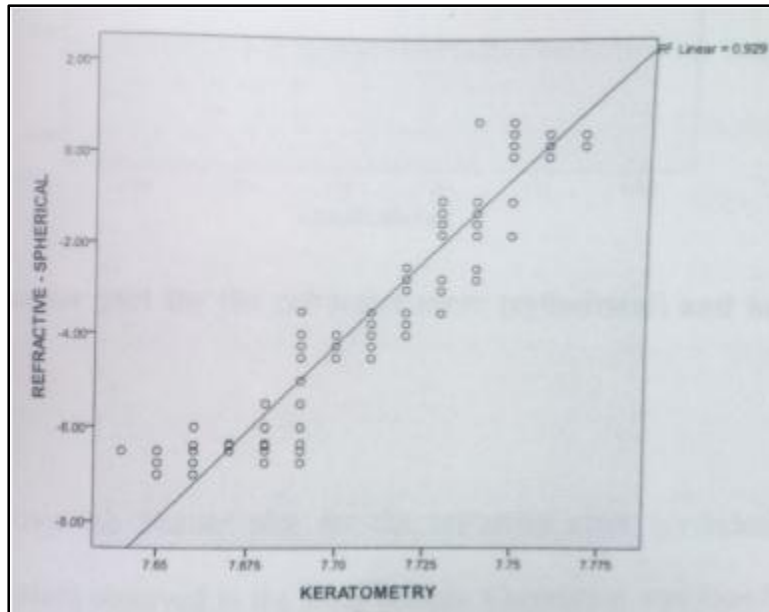


Fig. 8: Scatter plot for the refractive error (spherical) and Keratometric values

Figure 8 shows the scatter plot for the refractive error (Spherical) and Keratometric values observed in the study sample. Correlation was found high in the case of refractive error (Spherical) and Keratometric values in the whole population ($r^2 = 0.929$).

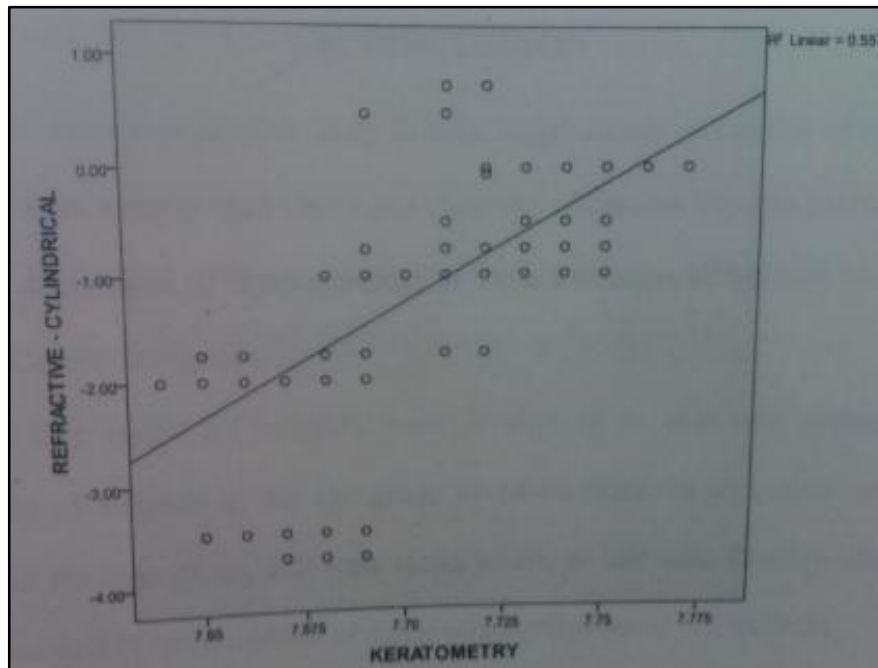


Fig. 9: Scatter plot for the refractive error (cylindrical) and Keratometric values

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Figure 9 shows the scatter plot for the refractive error (Cylindrical) and Keratometric values observed in the study sample. Correlation was found high in the case of refractive error (Cylindrical) and Keratometric values in the whole population ($r^2 = 0.557$).

DISCUSSION: This was a comparative study in axial length of eye and radius of curvature of cornea between healthy individuals and clinically diagnosed myopia patients visiting outpatient department of Ophthalmology at Vydehi Institute of Medical sciences and Research Centre, Bangalore.

In this study the subjects were divided into case and control groups comprising of subjects in the age group of 18-40 years. In this study out of 278 subjects in the case group, 127 were males whereas 150 were females. The control group consisted of equal number of males and females out of 102 subjects.

It was seen that there was significant correlation between axial length of the eye and refractive error of the eye {table 5}. It was also observed that there was correlation between the refractive error of the eye and radius of curvature of cornea although less when compared with the change in axial length.

The axial length (AL), radius of curvature of cornea (CR), AL/CR ratio and Keratometric values observed in our study population are in general agreement with those provided by other author for similar population samples¹³. This data also confirm the significant differences observed in axial length and radius of curvature of cornea according to subject sex. Consistent with previous reports, AL was found to be approximately half an mm (0.5mm) greater in men than in women, and could be attributed to the relatively increased height and weight of men.¹⁴

Myopic eyes were clearly different from emmetropic eyes before the onset of myopia in terms of refractive error, axial length, relative peripheral refractive error, and growth rates for these variables. In this study the refractive error value that was recorded in the control groups were low compared to case groups (Table 3). This study falls in line with the findings of previous longitudinal analyses in which early refractive error was used as a predictive factor.¹⁵

With reference to axial lengths, the case group recorded high values compared to the control groups (Table 5). Our correlates the previous findings where the axial lengths were higher in case groups than the controls employed in the study.¹⁶

The most relevant clinical environmental factor typically associated with myopia in humans is near work. It was found that the 70.5% of the cases recorded yes for the history of near work while in control group it was only present in 29.2%.

With reference to the family history in the sample population, it was noted that 82.3% of the case group had family history where as it was 46.7% in the control group.

Other personal characteristics, such as value systems, school achievements, time spent in reading, language abilities, education, higher IQ and time spent in sport activities correlated to the occurrence of myopia in studies.

CONCLUSION: The following are the conclusions that are made out of the present investigation:

- A greater AL of the eye was observed in the case group examined, irrespective of other factors such as changes in CR. Hence, axial lengthening is the main morphological factor related to myopia.
- The CR is not a determining factor of the RE, although we observed a tendency towards smaller radii of curvature in case group myopias.

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- The cornea seems to play an emmetropizing role in preserving emmetropia or low myopia. This emmetropizing capacity could be insufficient when there is excessive axial lengthening of the ocular globe, with the consequent appearance of myopia.
- Myopia seems to be associated more with family history and becomes more pronounced when associated with near work.

RECOMMENDATIONS: The following are the recommendations of this study:

- Do not use glasses or contact lenses, which are stronger than necessary, i.e. avoid any over-correction. You might use “main glasses/contact lenses” which are under-correcting and you see additional glasses for perfect distant vision.
- For near work keep a reasonably large distance to your book/paper/computer screen, or better use plus or under-correcting or bifocal glasses maybe with an appropriate prism (not for driving a car and permanent under-correction can result in a blur picture on the retina, which could result in deprivation myopia, too). Plus glasses for extensive near work are of advantage as well for people who are not myopic yet, but are at risk, and for people, who wear contact lenses.
- Cold-colour light should be preferred to warm-colour light. Do not read and don't do near work at bad light, 300 Lux are the minimum. Interrupt your near work every 30 minutes by focusing on distant objects and relax your eyes especially in the evening. Wearing plus glasses for some minutes a few times per day might block the onset of myopia.
- Some exercising of the accommodation by alternating focusing near and far objects can be helpful.
- Do not use extremely small glasses.
- Regular physical exercises, preferably outdoors can help reduce the intraocular pressure.
- Physical exercises can have a positive impact on the blood circulation in the eye, and promote NO metabolism.
- Consider rigid gas permeable contact lenses (RGP). Soft contact lenses were not reported to show this positive effect. Consider orthokeratology.
- Additional supplements of multiple vitamins (especially vitamin E, B2, B6, folic acid), minerals (especially calcium, copper and zinc) and especially flavonoids are recommended for progression of myopia.
- Keep a healthy and balanced diet, which is low in sugar and low in refined carbohydrate (incl. white wheat), low in sodium, low in fat except omega-3 (fish) oil, and have plenty of (if possible unprocessed) vegetables and fruits.

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